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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/530,588	05/05/2000	KIMIHIRO MATSUSE	2312-0866-2P	6686

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EXAMINER

QUACH, TUAN N

ART UNIT PAPER NUMBER

2814

DATE MAILED: 11/26/2001

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/530,588

Applicant(s)

MATSUSE ET AL.

Examiner

Tuan Quach

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 31 October 2001.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 28-62 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 28-62 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 13.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Claims 39, 40, and 62 are amended. The Declaration and IDS filed October 31, 2001 have been received.

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 36-42 and 57-62 are rejected under 35 U.S.C. 103(a) as being unpatentable over Agnello et al. or Kasai et al. taken with Fleming et al.

Agnello et al. '166 teach forming multilayer structure comprising polysilicon barrier refractory metal silicon nitride intervening layer, upper conductor thereon, e.g., including refractory metal such as W. The use of TaSiN and the replacement of W for Ta is also taught. See column 5 lines 10-17, line 56 to column 6 line 26.

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Kasai et al. teach polysilicon, barrier WN, metal gate structure. See page 497, Fig. 2, page 499.

The recitation of the atomic composition of nitrogen in the tungsten nitride, and of silicon or nitrogen composition in the tungsten silicon nitride correspond to well known optimization of one skilled in the art to obtain the desired barrier characteristics and as such would have been obvious given the teachings of Fleming et al., Figs. 1, 4, 5, and 9, evidencing the desired composition to obtain a desired resistivity, and of Agnello et al., column 3 line 37 to column 4 line 1, column 5 line 64 to column 6 line 8, evidencing the routine optimization of forming varying compositions for such layer to optimize layer resistance, diffusion barrier characteristics, and stability.

Claims 38, 41, and 59 are rejected under 35 U.S.C. 103(a) as being unpatentable over Agnello et al. or Kasai et al. taken with Fleming et al. as applied to claims 36-42 and 57-62 above, and further in view of Wolf et al.

Although the references do not recite alternative conductor materials, it would have been obvious to one skilled in the art to have employed such conventional conductors to improve device characteristics as evidenced by Wolf, pages 192-193, e.g., low resistivity, good electromigration resistance, etc.

Claims 39, 42, and 60 are rejected under 35 U.S.C. 103(a) as being unpatentable over Agnello et al. or Kasai et al. taken with Fleming et al. as applied to claims 36-42, and 57-62 above, and further in view of Katoh.

Although the references as applied above do not recite all the alternative insulating materials, it would have been obvious and would have been within the

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purview of one skilled in the art to have employed in Agnello et al. the alternative insulating materials in these claims since such correspond to conventional and advantageous insulating materials as evidenced by Kato, column 1 line 60 to column 2 line 13, lines 53-64. Regarding any other insulating materials, such use would have been obvious given the acknowledgement of such alternative materials in the specification page 12 lines 10-12, page 13 lines 14-15. In addition, official notice is given regarding any such use of such materials for insulating layer.

Claims 28-35 and 43-56 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sasaki et al. '306 or Hah et al. '102 taken with Chiang and further in view of Fleming et al. and Agnello et al.

Sasaki et al. teach forming contact hole through insulating layer using barrier material comprising WSiN 39 followed by conductor such as W or Cu 40. The planarization to form the plug is also shown. See the abstract and figures.

Hah et al. also teach forming contact hole in insulating film 36 followed by barrier tungsten nitride and conductor 44. See the abstract and figures.

Chiang et al. teach multilevel interconnection including barrier in openings, followed by conductor and then planarized, e.g., by CMP. Suitable barrier materials include various metal nitrides and metal silicon nitride, e.g., WN, tantalum silicon nitride, and conductor including Cu, tungsten, etc. See column 13 line 35 et seq., column 18 line 64 to column 19 line 18.

It would have been obvious to one skilled in the art in practicing the Sasaki

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et al. or Hah et al. process to have employed on a conductor level or a metal layer in addition to a diffusion layer since such is conventional and advantageous as evidenced by Chiang et al. wherein such barrier structure is provided in multilevel interconnect. Conversely, it would have been obvious to one skilled in the art in practicing the Chiang et al. process to have employed the barrier materials taught in Hah et al. or Sasaki et al. since such correspond to conventional and suitable materials taught therein.

The recitation of the atomic composition of nitrogen in the tungsten nitride, and of silicon or nitrogen composition in the tungsten silicon nitride correspond to well known optimization of one skilled in the art to obtain the desired barrier characteristics and as such would have been obvious given the teachings of Fleming et al., Figs. 1, 4, 5, and 9, evidencing the desired composition to obtain a desired resistivity, and of Agnello et al., column 3 line 37 to column 4 line 1, column 5 line 64 to column 6 line 8, evidencing the routine optimization of forming varying compositions for such layer to optimize layer resistance, diffusion barrier characteristics, and stability.

Regarding the well known alternative materials and insulating materials such is well known in the art as delineated above and as acknowledged by applicant and as such would have been obvious.

It would have been obvious and would have been within the purview of one skilled in the art to have employed such barrier between layers where barrier effect is desired, to have employed in conventional openings including contact openings or via openings where desired.

The declaration under 37 CFR 1.132 filed October 31, 2001 is insufficient to overcome the rejection of the pending claims based upon references as set forth in the last Office action as delineated and applicant's arguments filed October 31, 2001 have been fully considered but they are not persuasive.

The data provided in Fig. 1 does not show the unexpected results regarding the sheet resistivity. The claimed range for x is 0.5 to 1. Initially, the figures provided are of poor quality making it difficult to consider. Applicant is requested to provide discernible and/or clear figures. The comparison with values outside the claimed range does not appear to be sufficient and, in addition, Fig. 1 supports that value outside the claimed range, e.g., $x=2.0$ would have substantially similar sheet resistance. The data provided in Fig. 2 also does not show the unexpected advantage regarding the sheet resistance. No comparison with values outside the claimed range of y and z for consideration as to the alleged advantages. In addition, the value of $y=2$ and $x=2$ appears to show substantially similar sheet resistance. Regarding Fig. 3, it cannot be determined which values are being employed within the range and thus cannot be determined whether it is commensurate with the scope of the claimed range.

The values of x , y , z in Fig. 4 further are not specified.

Regarding Fig. 5, again comparison with that of structures having values outside the range is not shown.

Accordingly the unexpected results, and their being commensurate with the scope of the claims, cannot be established from the data provide. Furthermore, the prior art shows the use of nitrogen content to be about 50%, e.g., column 6 lines 5 et

seq., thus within the claimed range in the claims. It appears that such optimization to achieve optimal diffusion barrier and oxidation resistance properties while still maintaining reasonable resistivity is within the purview of one skilled in the art as evidenced by Agnello et al., column 6 lines 5-8.

See the reasons provided regarding the declaration.

Regarding applicant's argument that Fleming teach away from the claimed invention, this has been carefully considered but it cannot be seen how such teaching away is apparent from the statement relied upon by applicant. Furthermore, Fleming nowhere recites that the range claimed by applicant is not to be used.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Quach whose telephone number is 703-308-1096. The examiner can normally be reached on M - F from 9 to 5. The fax phone number for the organization where this application or proceeding is assigned is 703-308-7722.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



Tuan Quach
Primary Examiner